GAO

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General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-223582

March 18, 1988

The Honorable Edward J. Markey
House of Representatives

Dear Mr. Markey:

On January 15, 1987, you asked us to assess the December 1986 accident at the Surry nuclear power plant owned by the Virginia Electric and Power Company and provide information on several technical problems, such as pressurized thermal shock and reactor vessel embrittlement, that face aging nuclear power plants. This report presents our findings concerning the accident at Surry as well as a July 1987 incident at the Trojan plant in Oregon. We expect to provide a detailed report later regarding the technical problems facing older nuclear plants.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the appropriate congressional committees; the Chairman, Nuclear Regulatory Commission; and the Director, Office of Management and Budget. We will also make copies available to others upon request.

This work was performed under the direction of Keith O. Fultz, Senior Associate Director. Other major contributors are listed in appendix I.

Sincerely yours,

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

On December 9, 1986, a pipe rupture at Virginia Electric and Power Company's Surry Unit 2 nuclear power plant injured eight workers; four subsequently died. As a result of this accident, Representative Edward Markey requested GAO to assess the problems confronting aging nuclear plants, including the pipe degradation that led to the Surry accident.

This report addresses the Surry accident and, as agreed with Representative Markey's office, the July 1987 discovery of widespread pipe deterioration by the Portland General Electric Company at its Trojan plant in Oregon. It also addresses actions taken by the companies to identify and correct problems in their pipe systems and efforts initiated by the Nuclear Regulatory Commission (NRC) and the utility industry to prevent similar, future incidents. (See ch. 1.)

Background

Under the Atomic Energy Act, NRC regulates the construction and operation of nuclear plants and issues rules to ensure that the plants do not pose undue risks to public health and safety. As of November 1987, NRC had issued operating licenses to 109 plants. NRC focuses its regulations on safety equipment and relies on each utility to ensure that nonregulated plant systems operate properly. To provide guidance to the industry, the American Society of Mechanical Engineers has developed pipe thickness standards and suggested that utilities replace pipe that does not meet these limits. NRC has incorporated the industry standards into its regulations. However, neither NRC's regulations nor industry standards require utilities to inspect for the type of pipe degradation that caused the Surry accident and the widespread pipe damage at Trojan. (See ch. 1.)

Results in Brief

The events at Surry and Trojan raise questions about the long-term safety of pipe systems in nuclear power plants. Surry had been in service for 14 years when the accident occurred, and Trojan only 11 years. Further, the damage at Trojan was more widespread than Surry's and was found in both the NRC-regulated and nonregulated portions of the plant.

In response to the Surry accident, in July 1987 NRC required utilities to provide information on the extent of known pipe deterioration at each plant. As of January 1988, NRC staff identified 34 new and mature plants with erosion/corrosion damage. NRC staff expect to gather additional information and use it to determine whether specific regulatory

action is needed. In addition, a utility industry group has developed a program to help companies detect and repair pipe damage.

Principal Findings

The Surry Accident

The Surry accident surprised both NRC and the industry because it was the first time this type of accident caused fatalities at a nuclear facility. In December 1986, a valve in a main steam line closed which caused the pressure in other pipe systems to increase, and a rupture occurred. The steam released by the rupture not only damaged equipment but also resulted in eight worker injuries; four later died. Virginia Power concluded that the cause of the accident was erosion/corrosion caused by fluid passing through pipes at high temperature, pressure, and speed during the 14 years the plant had been in service.

Although the accident occurred at a pipe bend in the area of the plant that is not regulated by NRC, its effects cascaded across several regulated systems causing additional accident management problems. The steam released from the ruptured pipe activated several fire protection systems, which then adversely affected the air in the control room and the plant's security and communications systems. NRC staff told us these unexpected challenges to the plant's safety systems may be the more significant aspect of the incident.

Following the accident, Virginia Power performed extensive work at Surry Unit 2 and its three other nuclear plants to determine the extent of erosion/corrosion. As a result of these efforts, the company inspected about 1,500 components, replaced 184, and developed data that it will use to guide its erosion/corrosion program in the future. (See ch. 2.)

The Trojan Incident

Seven months after the Surry accident, Portland General, during planned refueling activities, reported to NRC that it discovered widespread erosion/corrosion in both the regulated and nonregulated portions of its Trojan plant. The discovery at Trojan was the first time that a utility found extensive damage in both portions. In addition, Trojan had been in service for only 11 years, and the utility found damage in straight sections of pipe, far away from pipe curves or other unique configurations where, on the basis of industry guidance, erosion/corrosion would have been expected.

The utility initiated a comprehensive program to correct the damage found at Trojan. It inspected and replaced all important safety components and damaged pipe where necessary, upgraded the plant's pipe monitoring program, and developed data to assess future erosion/corrosion problems. (See ch. 2.)

NRC's Response to These Incidents

NRC sent inspection teams to both plants and began to reassess its regulatory responsibilities. Although the Surry accident occurred in the nonregulated portion of the plant, pipe degradation at Trojan was found in the regulated and nonregulated portions. In July 1987 NRC required all nuclear utilities to provide information on the extent of known erosion/corrosion damage at their plants, as well as monitoring programs that are in place. As of January 1988, NRC staff had not completed their analysis of these data. However, the staff's preliminary findings indicate that 34 nuclear plants have some erosion/corrosion damage—the plants have been in service from 15 months to 20 years. NRC staff expect to collect additional information from utilities and decide in the summer of 1988 whether to recommend that the Commission take additional regulatory action regarding erosion/corrosion. The staff does not know, however, if the Commission will address this issue or the extent of the action it may take. (See ch. 3.)

Industry Initiatives

In addition to NRC's initiatives, the industry has taken steps to encourage utilities to identify and correct erosion/corrosion in nuclear plants. Various industry groups conducted workshops to exchange information on this condition. Further, the Nuclear Management and Resources Council, which serves as an interface between the nuclear portion of the industry and NRC, has recommended that companies develop an approach to identify, inspect, and repair erosion/corrosion damage. To assist in these efforts, the industry developed a computer program that utilities can use to identify areas in pipe systems that may be most susceptible to this condition.

Although many utilities are using the computer program to detect erosion/corrosion in their plants, no industry-wide commitment exists to implement the Council's recommendations to inspect for, and repair, degraded pipe. Consequently, short of an NRC requirement, no guarantee exists that utilities will take the actions needed to maintain the integrity of pipe systems at nuclear power plants. (See ch. 3.)

Recommendations

The December 1986 accident at Surry initiated a new era of understanding regarding erosion/corrosion at nuclear power plants. Since the accident, utilities found some erosion/corrosion in about 30 percent of the operating plants. Although NRC and the industry have taken some positive actions, no NRC requirement or industry commitment exists to ensure the integrity of pipe systems in nuclear plants. Due to the significance of the information that has been developed concerning erosion/corrosion at nuclear power plants, GAO recommends that the Chairman, NRC, require utilities to

- inspect all nuclear plants to develop data regarding the extent of erosion/corrosion in pipe systems, including straight sections of pipe;
- replace pipe that does not meet the industry's minimum allowable thickness standards; and
- periodically monitor pipe systems and use the data developed during these inspections to assess the spread of erosion/corrosion in the plants.

Agency Comments

GAO discussed the facts presented in this report with NRC staff and representatives from Virginia Power, Portland General, and the Nuclear Management and Resources Council. They generally agreed with the facts presented but offered some clarifications that were incorporated where appropriate. As requested, GAO did not ask NRC, the utilities, or the industry group to formally review and comment on this report.